

Total and Elastic pp Cross Section Measurements at RHIC with Polarized and Unpolarized Beams

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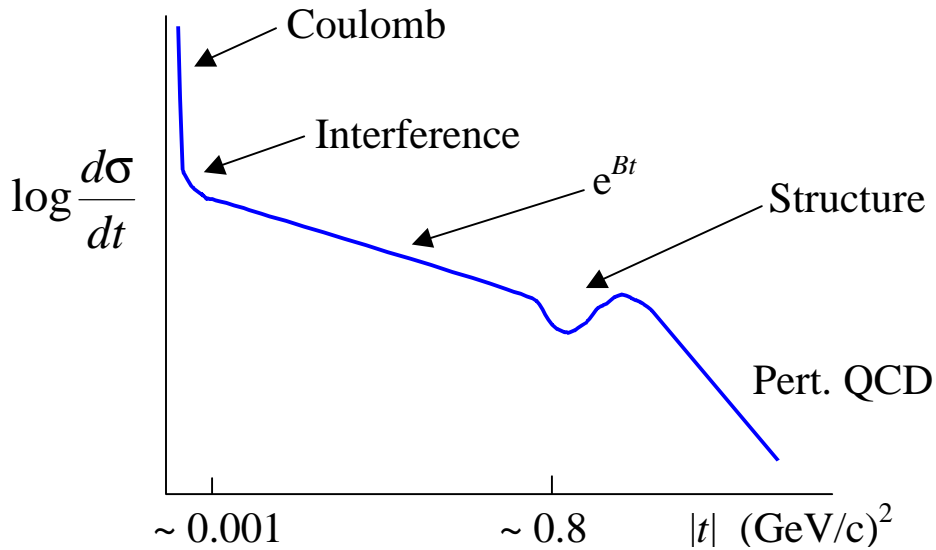
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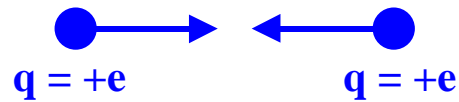
ELASTIC SCATTERING CROSS SECTION



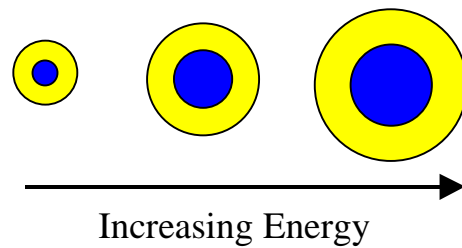
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|-------------------------------------|---|-------------------------|--------------|
| 1. Coulomb Region | $\frac{d\sigma}{dt} \sim \frac{1}{t^2}$ | – Normalization (L) | } Small t |
| 2. Coulomb – Nuclear Interference | | – “ ρ ” Value | |
| 3. Diffraction | $\frac{d\sigma}{dt} \sim e^{Bt}$ | – σ_{tot} | } Medium t |
| 4. Structure Region | | – Peaks & Bumps | |
| 5. Large $ t \geq 5 \text{ GeV}^2$ | | – Pert. QCD | Large t |

There are three regimes in elastic scattering:

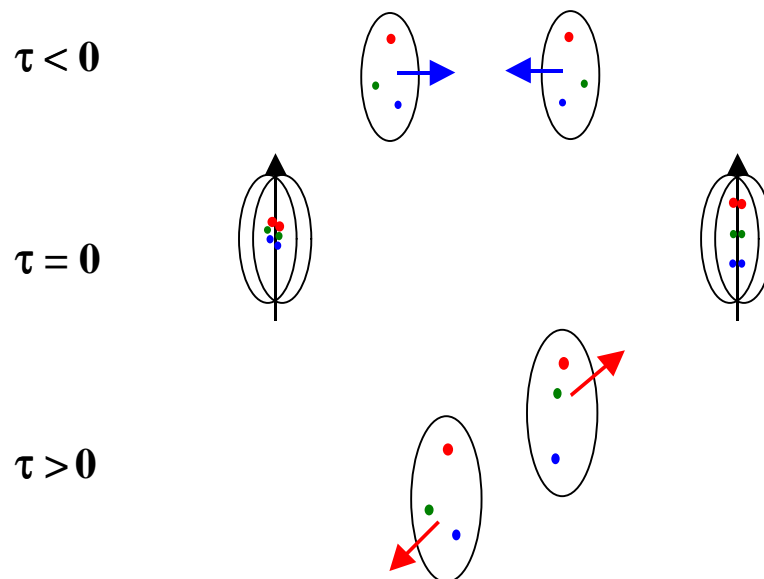
- I. Coulomb Scattering, small t – protons are point-like

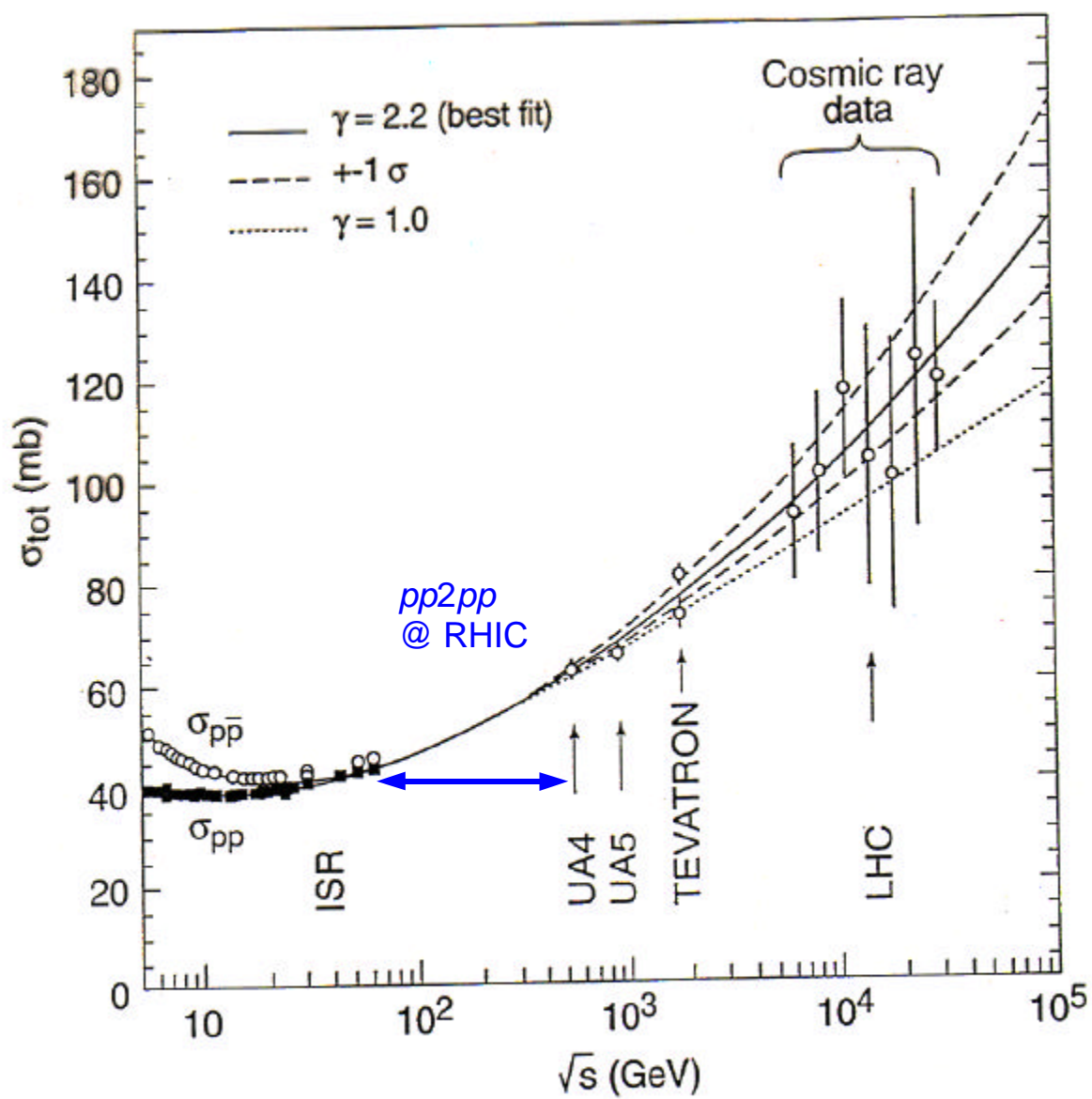


- II. Diffraction, medium t : – proton has a size and “some” structure



- III. QCD Regime, large t : – quarks, point-like constituents of protons scatter by exchanging gluons





$pp2pp \rightarrow \Delta\sigma_{\text{tot}} \sim 200 \mu\text{b}$
 (\sim size of the points)

PHYSICS PROGRAM

Study systematically pp elastic scattering with polarized and unpolarized beams $p_{lab} \leq 250$ GeV/c in both colliding beam mode and fixed target mode, using a polarized gas jet target.

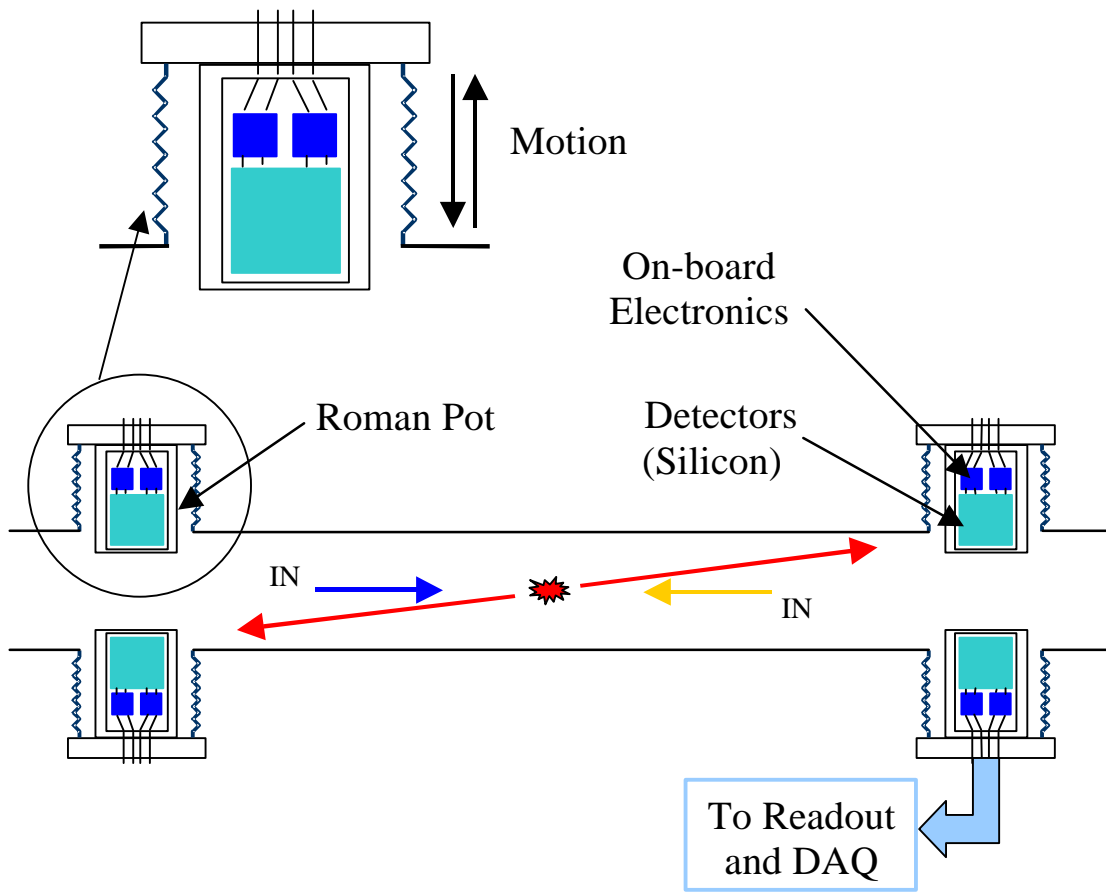
1. Polarized Beams to measure **spin asymmetries** A_N , A_{NN} , $A_{LL} \Rightarrow$ **helicity amplitudes** f_i which describe elastic scattering.

$$\begin{aligned} f_1 &\sim \langle ++ | M | ++ \rangle & f_2 &\sim \langle -- | M | ++ \rangle & f_3 &\sim \langle +- | M | +- \rangle \\ f_4 &\sim \langle +- | M | -+ \rangle & f_5 &\sim \langle ++ | M | +- \rangle \end{aligned}$$

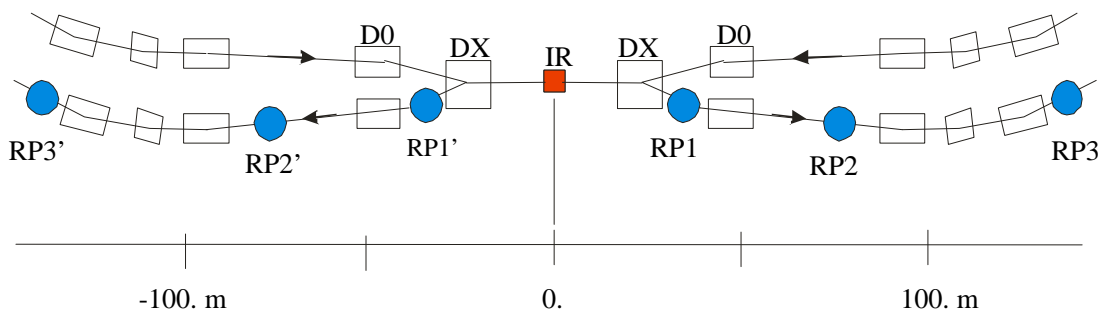
2. **Polarization observables will give access to spin degrees of freedom** \Rightarrow distinguish between nucleon structure models, like quark diquark model of the proton and its appropriate wave function.
3. **Using polarized jet target** \Rightarrow we will contribute to understanding and measurement of beam polarization by covering wide range of elastic reactions.
4. **In the medium t region**, $|t| < 1.5$ GeV² \Rightarrow study dynamics of long range strong interactions, the non-perturbative regime of QCD \Rightarrow **long range QCD** and confinement.
5. By appropriate veto system and trigger conditions, the experiment will also measure **single diffraction dissociation**.
6. **In the small momentum transferred $|t|$ region** \Rightarrow tests of general analytical properties of scattering amplitudes: analyticity, unitarity crossing symmetry.
7. With an additional magnet in the IR for momentum reconstruction \Rightarrow measure elastic scattering **in large t region** \Rightarrow test of **pQCD** calculations.

EXPERIMENTAL $pp2pp$ METHOD AT RHIC

Roman pot location is determined by parallel to point focusing.

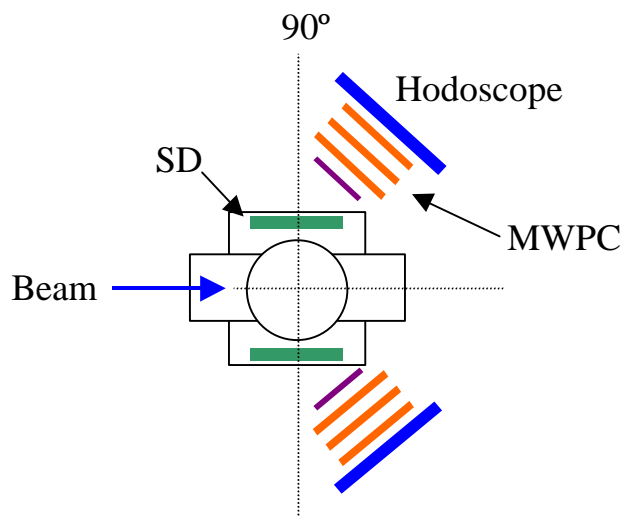
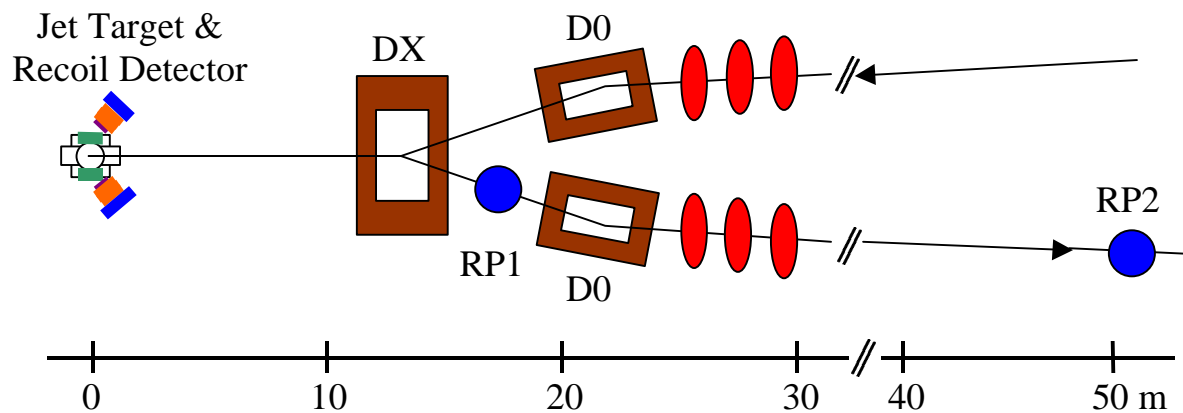


RHIC Intersection Region with PP2PP Basic CB Setup



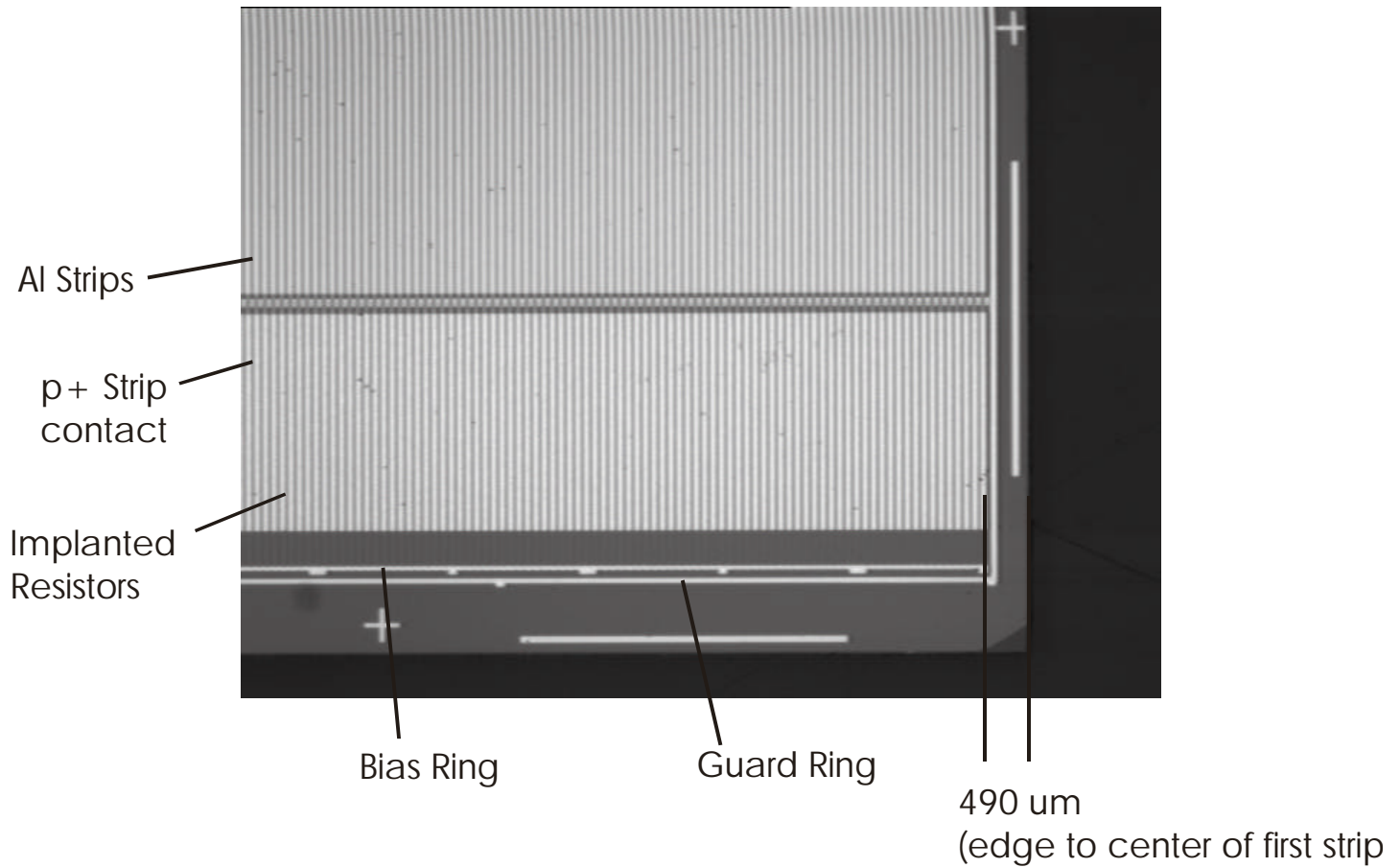
pp2pp SETUP WITH JET TARGET AND RECOIL DETECTORS

At luminosity $4 \times 10^{30} \text{ cm}^{-2} \text{ sec}^{-1}$, 200 hrs data on tape to acquire 1000 evts/0.02 GeV^2/c^2 bin will be needed.

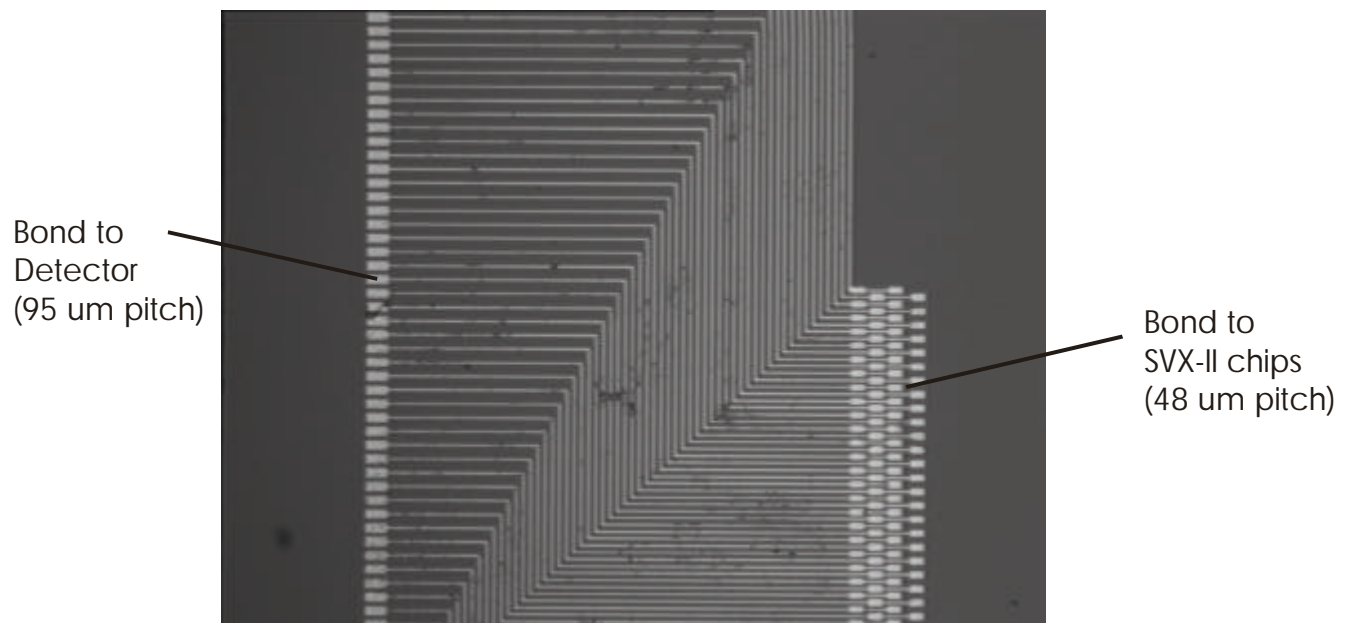


PP2PP Silicon for Y-view

Y 1.0 (Y-view detector, version 1.0)



Fan-in



STATUS AND PLANS

Our goal is to be ready for running in spring of 2001.

1. Experiment has scientific approval
2. Since the approval time we have:
 - Optimized the experiment, involving RHIC accelerator group to find placement for detectors (parallel to point focusing)
 - Finished the design of critical parts: Roman pots, detectors
 - Begun construction of prototype Roman pot and Si strip detector
 - Designed the veto system
 - Worked with the European groups to secure a polarized and unpolarized jet target for pp2pp and RHIC spin program

To meet our goal:

1. **FY 2000: construction and commissioning of detectors**, Roman pots, design jet target interface, work on the interface with BRAHMS.
2. **FY 2001: installation** of the experiment at RHIC including jet target.

More collaborators are welcome!

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<http://www.rhic.bnl.gov/export1/pp2pp/pp2pp.html>